Broken-helix antiferromagnetic order protecting a crystalline axion insulator phase and exotic surface states in EuIn2As2.

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EuIn2As2 is theoretically predicted to order in a collinear antiferromagnetic structure that preserves inversion symmetry and induces an axion-insulator state. Combining results from neutron diffraction, symmetry analyses and density functional theory, we show that EuIn2As2 instead exhibits low-symmetry helical antiferromagnetic order which breaks inversion. However, the combination of a 180° rotation and time-reversal symmetry (C2 x T= 2') elements still makes the compound a stoichiometric magnetic topological-crystalline axion insulator. Surfaces normal to the 2' symmetry axes show exotic gapless Dirac cones (DC) which are unpinned to specific time-reversal invariant momenta (TRIM). Gapped DC pinned to TRIM appear on the other surfaces. Dissipationless charge transport arises on the 2' protected surfaces while half-integer quantum anomalous-type conductivity occurs on the other surfaces. We predict that modest values of applied magnetic field can switch between the different surfaces states.